PATENT ABSTRACTS OF JAPAN

(11)Publication number : 2001-134628
(43)Date of publication of application : 18.05.2001

(51)Int.Cl. G06F 17/50
E04B 1/00

(21)Application number : 11-314631
(22)Date of filing : 05.11.1999

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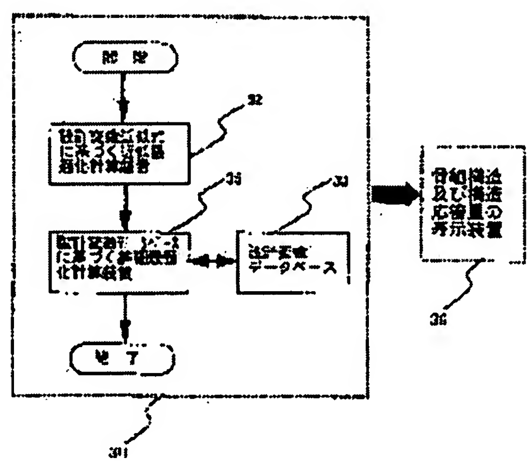
(54) DEVICE FOR OPTIMALLY DESIGNING FRAMED STRUCTURE

(57)Abstract:
PROBLEM TO BE SOLVED: To improve the safety and reliability of a framed structure by using a device that executes an automatic calculation and can obtain an optimum solution thereby executing a highly precise optimal framed structure design in a real design problem that the number of pieces of design variable data is very large in an optimal designing device using a genetic search method.



SOLUTION: This device for optimally designing the framed structure by using the genetic search method is provided with an approximate optimization calculating device using an approximate expression of discrete design variable data such as a framed member cross section size and a detailed optimization calculating device using the design variable data and constructs an optimization designing device for a framed structure by combing these two calculating devices. The approximate optimization calculating device using the approximate expression of the design variable data and the detailed optimization calculating device obtain the optimal solution of an excellent framed structure by continuously and automatically executing a two-stage optimization calculation no matter how many pieces the number of pieces of design variable data is.

LEGAL STATUS

[Date of request for examination]

[Date of sending the examiner's decision of rejection]

[Kind of final disposal of application other than the examiner's decision of rejection or application converted registration]

[Date of final disposal for application]

[Patent number]

[Date of registration]

[Number of appeal against examiner's decision of rejection]

[Date of requesting appeal against examiner's decision of rejection]

[Date of extinction of right]

* NOTICES *

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to the design equipment to which hereditary heuristics was especially applied as the optimization count technique with respect to the soil structure design equipment which consists of combination of soil structure response calculus, such as the finite element method or a theoretical analysis type of a beam, and the optimization count technique for the purpose of the optimization design of soil structure.
[0002]
[Description of the Prior Art] Soil structure is used as a support of a comparatively small device or equipment, and also it is used for the object for self-weight support and the object for earthquake-proof of the high-rise or large-sized structures, such as a building or a boiler for thermal power stations, and the application is large.
[0003] As a general technical problem for rationalizing such soil structure, equipment which carries out the optimization design of the soil structure automatically is desired, and various equipments are developed to this.
[0004] In order to show an example of soil structure, the bird's-eye view of the soil structure 13 of the boiler plant for thermal power stations general to drawing 18 is shown. A commercial plant is the soil structure 13 which supports the boiler 12 which is the amount of Oshige by about 3000 iron bony septum material 11. Although the-one arrangement of one of the iron bony septum material 11 in such large-scale soil structure 13 and optimization design equipment which can calculate combination with the optimal cross-section dimension were especially desired from the former, the optimization design equipment which meets this request did not exist until now.
[0005] Before describing the conventional technique relevant to the optimization design of the above-mentioned soil structure, the basic vocabulary in an optimization design method is explained first. Then, the application to the description and conventional technique is explained as two typical optimization techniques about "the optimization technique based on sensibility" which is a conventional method, and the "hereditary heuristics" which is a new hand method. An optimization design is a design which calculates the "optimum solution" of the "design variable" which satisfies a "constraint" and minimizes a "performance index."

[0006] A designer chooses "a design variable Xi" from the structure parameters currently used by the real design, and as shown in a formula (1), two or more use is usually carried out. The cross section of the iron bony septum material 11 in drawing 18 etc. is mentioned as an example.

X= {X1, X2, ..., XM} .... (1)

M is the number of design variables here.

[0007] A "constraint" is the formula which described the constraint about the amount of responses with the need of being on a design among the amounts of structure responses, such as stress and deformation, and being specified. As a class of constraint, the thing of a formula, such as being shown in a formula (2) and a formula (3), and inequality exists, and it becomes plurality respectively in many cases.

gi(X) <=0 (i=1-k) .... (2)

hj(X) =0 (j=1-m) .... (3)

k is the number of inequality constraints here, and m is the number of equality constraints.

[0008] A "performance index" is an amount which a designer wants to minimize or maximize about the structure, for example, the weight of the structure etc. is chosen. Hereafter, a performance index is expressed with f (X).

[0009] Next, the two typical optimization count technique is described using drawing 19 - drawing 24 . In addition, the two optimization count technique is compared to a mountain-climbing problem, and drawing 19 - drawing 24 explain it.

[0010] Drawing 19 explains "the optimization technique based on sensibility 4", draws contour-line 4a of the performance-index value 6 into the two-dimensional variable space coordinates 5, and is the top view having shown the example as which an optimization problem is expressed in one crest, i.e., a monophasic problem. Drawing 20 is the side elevation of drawing 19 .

[0011] "The optimization technique based on sensibility 4" is an approach of starting count from initial value 9b of a design variable, following the root where sensibility 4 becomes large most while calculating the sensibility 4 which is the process which carries out optimization repetition count, and is the inclination of contour-line 4a, and searching the minimum distance for summit-of-the-mountain, i.e., optimum solution, 9a.

[0012] Although this optimization technique is the monophasic problem shown in drawing 19 and drawing 20 and is effective in the problem for a continuous design variable, it is not effective to the so-called multiphasic problem which consists of two or more crests like drawing 21 and drawing 22 . Depending on how to give initial value depending on the location which initial value 9b gave, optimum-solution 9a whose solution is the highest summit of the mountain is not obtained, but the reason tends to lapse into the local solution 9 which is the summit of the mountain which is not not much high.

[0013] There is invention given in JP,59-83207,A as a typical conventional technique for solving the above-mentioned problem. It aims at what this technique "shortens sharply the time amount which calculates an optimum solution for in the optimization technique based on sensibility while suppressing small the fluctuation given to a controlled system by appointing a retrieval starting point in the field predicted that an optimum solution exists" about an optimum control method. Optimization of the opening of some pressurization valves for performing the optimal employment of a steam turbine generation-of-electrical-energy facility as an example of this technique is performed.

[0014] However, in order to appoint a retrieval starting point in the field predicted that an optimum solution exists in said conventional technique, it is necessary to accumulate the know-how about a control problem, and automation of control is impossible. Furthermore, when said conventional technique is applied to the optimization problem which makes a design variable about 3000 skeleton members which are the objects of this invention, are recording of know-how not only takes huge time amount, but it cannot acquire an optimum solution by design automation.
[0015] Next, the new hand method "hereditary heuristics" developed in order to improve "the optimization technique based on sensibility 4" is explained using drawing 23 and drawing 24 . In addition, drawing 23 shows the top view of a multi-crest problem, and drawing 24 shows the side elevation.
[0016] Hereditary heuristics is an optimization technique which simulated the evolution process of a living thing based on gene information. By this technique, employing efficiently experience of the crest climbed till then in the multiphasic problem shown in drawing 23 and drawing 24 , by random-search 4b called "the crossover and mutation" which are mentioned later, retrieval with a large visual field is attained and possibility of arriving at the summit of the highest crest, i.e., optimum-solution 9a, is high compared with the optimization technique based on sensibility.
[0017] The flow of count by hereditary heuristics is shown in drawing 25 . In this, "the creation 21 of a chromosome", "count 21a of the amount of structure responses", "selection 22", "crossover 23", and "the mutation 24" which are five important processes are explained briefly.
[0018] It changes into the chromosome 26 which expressed the real number value of design variables X1, X2, and X3 with the creation process 21 of a chromosome with the binary number first in hereditary heuristics. Next, the performance-index value (it is called a goodness of fit 27) of a chromosome 26 is calculated by carrying out response count by a finite element method etc. by computation 21a of the amount of structure responses using this chromosome 26.
[0019] Weight is attached to a chromosome 26 according to the magnitude of a goodness of fit 27, and only the large chromosome 26 of a goodness of fit 27 is made to survive in the selection process 22. Three, X1, X2, and X3, are shown in drawing 25 as an example of "a chromosome 26." Among these three chromosomes 26, the goodness of fit 58 of X1 is the largest, and it turns out that it is next the order of X2 and X3. According to the magnitude of the goodness of fit 27 of a chromosome 26, the rotation roulette 28 which made weighting the area of a slot is shown in drawing 25 . It turns out that the goodness of fit 27 expresses with the ratio of area the probability for each chromosome 26 to be chosen as descending.
[0020] In the lottery of public lottery, a success-in-an-election number is selected by turning roulette and shooting an arrow. Like this, by selection 22, the roulette 28 shown in drawing 25 is simulated in a computer using a random number, and actuation which a goodness of fit 27 makes survive the large chromosome 26 as much as possible is performed.
[0021] The process which chooses two or more pairs out of the chromosome which survived by selection 22, exchanges the numerical train of these pairs partially, and generates a new chromosome is crossover 23. As an example, the case where X1 and X2 of drawing 25 survive by selection is considered. In crossover 23, after choosing two or more pairs 29a and 29b of a chromosome (the chromosome chosen by doing in this way

is called "Parents 29a and 29b") and choosing these parents 29a and 29b from the surviving chromosomes, as * section of drawing 25 shows, a numerical train is exchanged partially and the two "children 29c and 29d" is newly generated.
[0022] The children 29c and 29d who inherit the numerical train pattern of the parents 29a and 29b who were excellent with this actuation are made. The count which performs crossover 23 is given by the probability. For example, the probability which crosses is set to 0.03 when performing three crossovers in 100 chromosomes 26. Although one pair of a chromosome 26 is chosen whenever it crosses once, which pair is chosen determines with a random number. Moreover, it determines by the random number whether it crosses in which location in Parents' 29a and 29b numerical train.
[0023] When it crosses, the numerical train pattern of a chromosome is easy to be limited, and the space of retrieval may narrow. The process in which this is avoided is "mutation 24." If an example explains this process, as shown in ** section of drawing 25 , it will be changing a part of "1" of the numerical train of "child 29c", and the value of "0", and making new "child 29e", and the random nature of retrieval will be held by the repeat of this actuation. The count which performs mutation 24 as well as crossover 23 is given by the probability. For example, the probability is set to 0.02 when performing 2 times of mutation in 100 chromosomes 26. For which chromosome 26 mutation 24 is carried out in which location of a numerical train determines with a random number.
[0024] However, although it can say that hereditary heuristics is suitable for optimization of a discrete design variable, there is a limitation in the number of the design variables which can be dealt with. An optimum solution is not necessarily acquired simply in the place which merely applied hereditary heuristics to the large-scale actual design problem simply.
[0025] There is invention given in JP,7-134700,A as a conventional technique which solves such a trouble. This technique shows the configuration of that design equipment 1102 to drawing 26 about plant optimization design equipment. This design equipment equipment 1102 is equipment equipped with the simulator 1101 through the input/output interface section 1106, the optimization count section 1105 by hereditary heuristics, and data files 1103 and 1104.
[0026] With this technique, when applying hereditary heuristics to an actual problem, it is supposed that the actuation which suited that problem is required. The interpretation (heuristics) by the designer is specifically introduced, the valuation basis in a design problem, the range of a design variable, etc. are given using a simulator 1101, and the optimum solution is calculated by trial-and-error.
[0027] This technique is applied to the design of a heat exchanger network, the class and range of design variables (for example, a heating area, the rate of splitting, etc.) which are dealt with to an operation pattern are changed, and optimization count is performed.
[0028] However, with the above-mentioned conventional technique, if the designer who has the know-how about the target design problem does not do trial count, a solution is not acquired. Furthermore, when the above-mentioned conventional technique is applied to the optimization problem which makes a design variable about 3000 skeleton members which are the objects of this invention, an optimum solution cannot be acquired by design automation as well as are recording of know-how taking huge time amount.
[0029]
[Problem(s) to be Solved by the Invention] It is in the technical problem of this invention canceling the fault in the above-mentioned conventional technique, and solving the

following technical problem.
(1) In the optimization design equipment using hereditary heuristics, in the real design problem from which the number of design variable data becomes huge, carry out automatic ticketing which was impossible until now, and offer the equipment which makes it possible to acquire an optimum solution.
(2) With equipment given in the above (1), operation of the highly precise optimal soil structure design is enabled, and make it possible to improve the safety of soil structure, and dependability.
[0030]
[Means for Solving the Problem] The above-mentioned technical problem is attained by the following solution means. That is, in the soil structure optimization design equipment using hereditary heuristics, the approximation optimization count equipment which uses the approximate expression of discrete design variable data, such as a skeleton member cross-section dimension, and the detail optimization count equipment which uses these design variable data are formed, these two count equipments are combined, and the optimization design equipment of soil structure is constituted.
[0031]
[Function] As mentioned above, however the number of design variable data may increase by carrying out two steps of optimization count automatically continuously with the approximation optimization count equipment and detail optimization count equipment using a design variable data approximate expression, the optimum solution of good soil structure is acquired.
[0032]
[Embodiment of the Invention] The gestalt of operation of this invention is explained with a drawing below. As a gestalt of operation by this invention, the display 36 of optimal soil structure design equipment 30, soil structure, and the amount of structure responses is shown in drawing 1 . Optimal soil structure design equipment 30 consists of approximation optimization count equipment 32 based on a design variable approximate expression, detail optimization count equipment 35 based on the design variable database 33, and a design variable database 33. Hereafter, the configuration of approximation optimization count equipment 32 and detail optimization count equipment 35 is explained in order.
[0033] The configuration of approximation optimization count equipment 32 is shown in drawing 2 . Although drawing 2 is the same as drawing 25 fundamentally used by outline explanation of hereditary heuristics, it is the point that the place in which the change-of-variables subroutine 128 by the design variable approximate expression was formed is different. With this equipment 32, approximation optimization count only for the cross section 1126 of a skeleton member is carried out as a design variable.
[0034] The configuration of detail optimization count equipment 35 is shown in drawing 3 . Drawing 3 is the same as drawing 25 fundamentally used by outline explanation of hereditary heuristics. With this equipment, detail optimization count for member cross-section property data, such as the cross-sectional area of a skeleton member, a cross-section second moment, a section modulus, height, width of face, and board thickness, is carried out as a design variable 226.
[0035] The design equipment 30 shown in drawing 1 explains how to perform the optimization design of soil structure to each of the component 32 and 35 of design equipment 30, i.e., each equipments, and the design variable database 33.

[0036] The design variable database 33 is explained first. This database 33 is related with the skeleton cross-section member 41 shown in drawing 4 . As a cross-section property of the skeleton cross-section member 41, although there are the cross-section second moments I2 and I3 of the circumference of the biaxial 2 and 3 shafts 3 besides the cross section A, width of face B, height H, and board thickness t1 and t2, section moduli Z2 and Z3 of the circumference of the biaxial 2 and 3 shafts 3, etc., some databases 33 in which all these cross-section properties were summarized are shown in drawing 5 .
[0037] here -- biaxial [of H mold cross-section member 41] -- it is the shaft which divides H mold cross section in drawing 4 into two in a lengthwise direction in 2. Moreover, it is the shaft which divides H mold cross section into two in a longitudinal direction in three shafts 3 of H mold cross-section member.
[0038] Drawing 5 all contains cross-section properties, such as the cross section Ai of the i-th member corresponding to the member number i, and cross-section second-moment I3i of the circumference of three shafts 3, by the number N individual of material (about [Usually] N= 1000). In order that carrying out optimization count for the cross-section second moments I2 and I3 besides the cross section A which is cross-section property data, width of face B, height H, and board thickness t1 and t2, and all the section moduli Z2 and Z3 may search for a solution out of an astronomical number of combination, the way things stand, an optimum solution is not acquired in practice. Then, optimization count was divided into two, approximation optimization and detail optimization.
[0039] An operation of the approximation optimization count equipment 32 shown in drawing 2 is explained. The place in which the change-of-variables subroutine 128 according [this equipment 32] to a design variable approximate expression was formed is the description. With this equipment 32, it is the structure which can carry out efficient approximation optimization count by dealing with only the member cross section 1126 in the database 33 shown in drawing 5 as a design variable, and expressing the cross-section second moments I2 and I3 which are other cross-section properties, section moduli Z2 and Z3, height [of a member] H, width of face B, board thickness t1, and t2 grade as a function of the cross section A.
[0040] Hereafter, the approximate expression used in the change-of-variables subroutine 128 is explained concretely. Drawing 6 - drawing 13 are drawings which arranged cross-section properties other than the cross section A in the database 33 shown in drawing 5 , and the relation of the cross section A, and are scaling the axis of ordinate and axis of abscissa in these drawings with the predetermined value.
[0041] Drawing 6 shows the cross-section second moment I3 of the circumference of three shafts 3, and the relation of the cross section A. The cross-section second moment I2, the cross section A, and drawing 8 of the circumference of biaxial 2 drawing 7 The section modulus Z3 and the cross section A of the circumference of three shafts 3 In drawing 9 , width of face B, the cross section A, and drawing 12 show board thickness t1 and the cross section A, and, as for the section modulus Z2, the cross section A, and drawing 10 of the circumference of biaxial 2, drawing 13 shows the relation between board thickness t2 and the cross section A, as for height H, the cross section A, and drawing 11 .
[0042] The approximation curve 102 could be drawn about the data 101 of the cross-section second moment I3 shown in drawing 6 , and this showed that the cross-section second moment I3 could be expressed with a formula (4) in approximation as a function of the cross section A.

I3=1/betaI3x3.74x(betaAxA) 1.8 ...... (4)
betaI3 are the scaling multiplier ofI3 here, and betaA is the scaling multiplier of A.
[0043] Similarly the approximation curve 202 can be drawn also about the data 201 of the cross-section second moment I2 shown in drawing 7 . Also about the data 301 of the section modulus Z3 shown in drawing 8 , the approximation curve 302 Also about the data 401 of the section modulus Z2 shown in drawing 9 , the approximation curve 402 The approximation curve 502 also about the data 601 of B shown in drawing 11 also about the data 501 of H shown in drawing 10 the approximation curve 602 The approximation curve 902 can be drawn, respectively also about - TA 901 of t2 which shows the approximation curve 702 to drawing 13 also about the data 701 of t1 shown in drawing 12 . The approximate expression acquired by drawing 7 - drawing 13 is shown in formula (5) - (11).
[0044]
I2=1/betaI2x0.58x(betaAxA) 1.96 ..... (5)
Z3=1/betaZ3x1.75x(betaAxA) 1.39 ..... (6)
Z2=1/betaZ2x0.33x(betaAxA) 1.51 ..... (7)
H =1/betaH x42.59x(betaAxA) 0.41 ..... (8)
B =1/betaB x35.8 x(betaAxA) 0.44 ..... (9)
t1=1/betat1x0.76x(betaAxA) 0.55 ..... (10)
t2=1/betat2x1.04x(betaAxA) 0.56 ..... (11)
here -- the scaling multiplier of betaI2I2 -- it is -- betaZ3Z3, betaZ2Z2, and betaH -- H and betaB -- each of B, betat1t1, and betat2t2 -- it is an scaling multiplier.
[0045] As mentioned above, cross-section property data other than the cross-sectional area A are expressed as a function about the cross-sectional area A, and it has become the structure which can carry out approximation optimization count with the sufficient effectiveness for the cross-sectional area A. In drawing 7 - drawing 13 , the example of the optimum solution 103 acquired by approximation optimization count is shown.
[0046] Here, the value 0.0001 is a value as an example to the last, and shows as a result of approximation optimization count (for example, the example to which an optimum solution 103 exists in the place this "0.0001").
[0047] If the calculation approach of an optimum solution 103 is explained briefly, as shown in a formula (4) - a formula (11), since the parameter of I3, I2, Z3, Z2, H, B, t1, and t2 grade serves as a function of the cross section A, only A is a variable.
[0048] Thus, when only A can deal with it as a variable, the data 201 in drawing 7 are data of the number of finite individuals (for example, N individual), for example, these have all become the function of A.
[0049] That is, if optimization count for A of N individual is carried out instead of performing optimization count for the data 201 of N individual, the optimum solution 103 of data 201 will be acquired subordinately.
[0050] The approach of computing an optimum solution 103 by optimization count for A of N individual concretely sets A of N individual as the seek area of an optimum solution 103, and extracts the chromosome used with hereditary heuristics from the inside. And an optimum solution 103 is acquired by repeat count of the flow shown in drawing 2 .
[0051] Then, detail optimization count for the cross-section property data 226, such as the skeleton member cross section A in drawing 3 , the cross-section second moment I3, a section modulus Z3, height H, width of face B, and board thickness t1 and t2, is carried out using the detail optimization count equipment 35 shown in the surroundings of this

approximation optimum solution 103 at drawing 1 .
[0052] A part of result of having applied to the optimization design equipment 30 shown in drawing 1 and soil structure, and the soil structure 13 which shows the display 36 of the amount of structure responses to drawing 18 , and having carried out optimization count is explained below. In addition, in this count, the self-weight and earthquake force which act on soil structure 13 as loading condition were taken into consideration. Among optimization problems, the performance index was set as soil structure AUW, and the conditions which the stress and deformation which are produced in the iron bony septum material 11 as a constraint become below an allowed value were given.
[0053] the conditions to which said loading condition is usually given by the aseismatic design of the boiler structure here -- it remains as it is and is the indispensable thing which cannot carry out the check of the earthquake-proof stability of the boiler structure without this condition.
[0054] The seek area of a detail optimum solution is set as the circumference of the approximation optimum solution 103 about data, such as all the cross-section properties specifically shown in drawing 5 about the count approach of the above "detail optimization count", i.e., "the cross section A, the cross-section second moments I3 and I2, section moduli Z3 and Z2, height H, width of face B, board thickness t1 and t2", etc. which are all contained by the number N individual of material. And a detail optimum solution is calculated by the repeat of the flow shown in drawing 3 .
[0055] The situation of convergence count is shown in drawing 14 and drawing 15 . The axis of abscissa in drawing 14 and drawing 15 shows the count of count repeatedly, and the axis of ordinate shows the value which scaled the minimum value of the performance-index values (weight) calculated in all chromosomes by the structural weight before optimization.
[0056] Here, the formula which draws the performance-index value 903 is as follows.
[0057]
[Equation 1]

here -- NT: -- all the numbers of iron bony septum material -- the die length [0058] of the cross-section Li:member i of the consistency Ai:member i of rhoS:iron In the approximation optimization count in drawing 14 , the convergence count according to the flow shown in drawing 2 is required. That is, convergence count which improves the goodness of fit of a chromosome 126 is needed with the goodness of fit judging subroutine 25 of a chromosome 126.
[0059] In the detail optimization count in drawing 15 , the convergence count according to the flow shown in drawing 3 is required like this. That is, convergence count which improves the goodness of fit of a chromosome 226 by the goodness of fit judging subroutine 25 of a chromosome 226 is needed.
[0060] Drawing 14 is in the "all chromosome" optimization situation by the approximation optimization count equipment 32 in drawing 1 , and the performance-index value 903 is converging it on the structural weight 0.94 times the value of before optimization by about 20 times of repeats. Drawing 15 shows the convergence count situation at the time of carrying out automatic application of the detail optimization count equipment 33 in drawing 1 at the circumference of the approximation optimum solution

acquired by approximation optimization count. It turns out that it is being completed as the structural weight 0.8 times the value of before optimization by the performance-index value 904, and the degree of optimization consists of approximation optimization count greatly by about 20 times of repeats.
[0061] The parameter of I3, I2, Z3, Z2, H, B, t1, and t2 grade is expressed with approximation optimization count of drawing 14 as a function of A, as it indicates a formula (4) - a formula (11) that it mentioned above, and count only for A is performed by it. This count result is as mentioned above.
[0062] On the other hand, in detail optimization count of drawing 15 , the seek area of a detail optimum solution is set as the circumference of an approximation optimum solution about data, such as all the cross-section properties shown in drawing 5 , i.e., "the cross section A, the cross-section second moments I3 and I2, section moduli Z3 and Z2, height H, width of face B, board thickness t1 and t2", etc. which are all contained by the number N individual of material.
[0063] In this case, since the seek area of an approximation optimum solution differs from the seek area of a detail optimum solution, it changes from 0.94 which is the value which the performance-index value 903 in drawing 14 converged to the value 1.05 at the time of convergence count initiation of the performance-index value 904 in drawing 15 . In detail optimization count, new optimization count is carried out starting with this value, and that which the performance-index value 904 converges on 0.8 as a detail optimum solution is obtained after all.
[0064] The soil structure before optimizing to drawing 16 is shown, and the soil structure after optimizing to drawing 17 is shown. Drawing 16 and drawing 17 display the part in which the attached structure of a coal bunker 71 or duct 72 grade exists with the soil structure in drawing 1 , and the indicating equipment 36 of the amount of structure responses.
[0065] In the structure shown in drawing 16 and drawing 17 , although member arrangement of a column 75 and a beam 76 is before and after optimization and is fixed, in both drawings, some cross sections of members 75 and 76 are changing. On the other hand, it is before and after optimization and the arrangement and the cross-section dimension of the brace members 73, 74a, and 74b which are shown by the dotted line in drawing are changed sharply.
[0066] Although the brace member 73 of cross-sectional area [section / of drawing 16 / dotted-line] is arranged before optimization if said concretely, it turns out that the number of 74a and 74b of a brace decreased, and distribution has arisen also in the cross-section dimension of Braces 74a and 74b as after optimization is shown in the dotted-line section of drawing 17 .
[0067] As mentioned above, when using the design equipment by this invention, the optimization design of soil structure could be carried out automatically, and it turned out that the structure after a design turns into the proper structure where the cross section and the number of use of a member were reduced.
[0068] As mentioned above, although the example of application to the boiler plant support soil structure of the soil structure optimization design equipment by this invention was described, especially this design equipment does not limit a structure object. It can apply also to soil structure with many [far] design variables, and a rational soil structure design is more possible than a boiler plant support skeleton.
[0069]

[Effect of the Invention] According to this invention, the following matters are realized.
(1) Arrangement of a skeleton member and the highly precise optimization design of a dimension can be carried out with automatic.
(2) Like the above (1), conventionally [automatic and since the rationalization design of soil structure can be performed with high precision], while reducing sharply the complicated analyses which had taken a designer's time and effort, since safety can fully be examined until it results in the detail section of structure, in addition to this, the dependability of all soil structures can be improved in addition to the skeleton for boiler support.